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THE INCIDENCE AND PREDICTABILITY OF WEAKNESS AND PULPINESS IN SIDE UPPER LEATHER*

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ABSTRACT

More than eight hundred cured hides in a range of 43 to 53 pounds cured weight were selected at a tannery for the purpose of investigating the incidence and predictability of pulpiness in side upper leather. The incidence of weakness was greater for Hereford hides than for Angus and Holstein hides. The weakness could be traced structurally to a poor architectural weave of the collagen fiber bundles in the leather where few fiber bundles were woven in a direction horizontal to the grain surface. By relating physical strength measurements, breed of animal and plumpness of the hide, a system for separating hides that produce weak leather has been evolved.

INTRODUCTION

The occurrence of weak pulpy textured leather used in the upper part of shoes has been growing in magnitude in the past decade. It is a serious problem not only because of the quality requirements of the military and domestic shoe manufacturers and the competitive position of leather in today's market but also because the condition originates from an inherent defect in the hide that can be aggravated but not remedied. Because of the seriousness of the problem, the

*Presented in part at the Sixty-first Annual Meeting of ALCA, Grand Hotel, Mackinac Island, Michigan, June 21, 1965.

**A report of work done under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research and Development Division of the Agricultural Research Service.

Department of Agriculture has sponsored at the Tanners' Council Laboratory a research program to investigate the incidence and nature of pulpiness in various breeds of cattlehides so that the weak leather producing hides may be sorted from the good hides and used for leathers other than shoe upper type.

That weakness in side upper leather is involved with inherent properties of the hide was first detected by Amos (1) of Australia who reported that some leathers were low in strength because the hides from which they were processed had a vertical fiber arrangement. He found this condition in a few salt cured Hereford hides and in one out of a selection of ten fresh Hereford hides. Later, Battles (2) brought to our attention an important observation that cured hides that were low in tensile strength when tested in the butt flap area in general produced weak leather whereas cured hides that were high in tensile strength in this area in general produced strong leather. Battles submitted a selection of weak and strong hide samples to us for a cure evaluation. Cross sections revealed that the cured hides were well preserved and that the weakness of some of the hides was apparently not related to bacterial or autolytic degradation.

As a result of these findings and from observations made by tanners that weak, pulpy leather occurred mainly when plump hides were being processed, research studies (3, 4) were conducted on extremely plump hides obtained fresh from a local slaughterhouse. Forty-six plump hides of known breed and take-off time were comprehensively examined physically and histologically before and after tannage and the studies revealed the following information. Pulpiness occurred frequently in side upper leather made from heavy, plump Hereford hides; however, light weight, plump Hereford and heavy, plump Angus hides were not entirely free of the condition. Pulpiness in side upper leather was traced to an inherent architectural structure in the raw stock in which the collagen fiber bundles were woven together loosely and at angles almost perpendicular to the grain surface. The kidney area is the location in a side which is most commonly involved with pulpiness because it is inherently the weakest area of the hide. The tensile strength of the fresh or cured hide, when the test is made in the kidney area, can often indicate whether or not the resultant side upper leather will be pulpy.

The information obtained from the above work was used as a basis for setting up further experimental procedures. Since pulpiness involves the architectural arrangement of the fiber bundles of the hide, physical strength testing and histological studies were the research approaches used. Because pulpiness involves mainly the kidney area, all samples for testing were taken from this position of the hide and its respective leather. To check whether or not pulpiness involves both sides of the backbone, samples from both kidney areas of the hide were examined. Seasonal trends were investigated by spacing six testing times every two months throughout the year. Areas, weights, breeds and take-off times were recorded for each hide enabling us to analyze the hide data systematically.

EXPERIMENTAL

Procedure at the Tannery

The experimental procedure at the tannery involved procuring 884 salt pack cured hides in a range of 43 to 53 pounds cure weight. One hundred thirty-four hides were selected in February 1964 and 150 hides were sampled in each of the five subsequent testing months, namely April, June, August, October and December. The February, April, June and August lots consisted of about one half Hereford and the other half mainly Angus and a few Holstein hides. The October sampling was about half Angus and half Holstein because only a few Hereford hides were available. The December sampling consisted of Hereford hides to make up for the lack of Hereford hide data in October.

Packer salt cured hides were selected and later cut into sides by tannery workers. A member of our staff went to the tannery and recorded the breed type and weight of each hide. He sampled each side in the kidney area along the backbone edge starting seven inches from the root of the tail, cutting a half-moon shape to about five inches into the hide and ending about 12 inches from the starting point. The hide samples were identified in respect to right and left sides, labeled with numbering tags and shipped promptly to the laboratory in plastic bags.

Using the tannery dies, a number was stamped into each side at the backbone edge toward the head from the sampling area, so that the identity would be known when the side was made into 4 oz. leather. The areas of the sides were not measured in the hide cellar because in the cured state the sides were unyielding and could not be flattened uniformly. The areas were recorded later "in the blue" by tannery workers using an Allis Chalmers measuring machine. The areas of the sides, the sorters' opinions concerning which of the leathers were pulpy and a set of leather cuttings taken immediately below and adjacent to the first sampling area were sent to us by tannery personnel.

Laboratory Testing of the Hide and Leather Samples

The hair was removed from the samples by clipping and the samples were fleshed. One inch square specimens were cut from the samples and placed in ten percent formalin for histological examination. Two tensile strength and two slit tear samples (5, 6) were die cut in a direction parallel to the backbone edge and the strengths were recorded on the Instron Testing Equipment. Two puncture tests were made with a modified hand driven puncture tester (7) using a ⅛ inch rod with a spherical tip piercing a specimen held between ⅜ inch ring clamps.

When the leather cuttings were received from the tannery, they were examined on the flesh side for the pulpy condition and any veiny appearance. They were conditioned in the constant temperature room at 70°F. and 50 percent relative humidity, die cut in duplicate for tensile strength and slit tear and tested in duplicate for Mullen grain crack strength.

Many bivariate statistical analyses were run on the data to find the hide test that would best predict the strength of the leather. Muliple correlation studies were also run to try to improve predictability.

For histological examination, 60 samples from each lot of 300 sides were selected; the selection was based on tensile strength data of the hides. The data were ranked in order of weak and strong, and ten matching left and right samples from low, medium and high strength hides were sectioned. Cross sections were rated for degree of preservation (8) and fat content. Horizontal sections were also made of many of the high and low strength hide samples. The horizontal sections representing a layer of about 0.085 to 0.100 inch below the epidermal surface were mounted and examined for differences in architectural weave. In addition weak and strong leather samples were cut into cross sections and examined in respect to the angles of weave (9) of the corium fiber bundles. The paraffin sectioning technique was used for leather in order to minimize structural disruption when the sections were mounted on slides.†

DISCUSSION OF RESULTS

Incidence of Pulpiness, Breed Differences and Seasonal Influences

Several of the objectives of testing a large population of hides were to determine the number of "weak" or "pulpy" leathers produced from a selection of hides, to establish breed differences and to check any seasonal trends. Before calculations could be made as to how many of the hides produced "weak" or "pulpy" leathers, definitions for pulpiness and weakness had to be established. Initially a leather was considered "pulpy" when the flesh surface of the leather showed prominent blood vessels and had an open porous structure (4); the grain side could have a mottled appearance but generally was smooth and had a fine break. These characteristics were associated with a "dead feel" and poor strength values which fell below the following limits in the kidney area: 1350 lbs./sq. in. for tensile strength, 325 lbs./in. for slit tear and 210 lbs. for Mullen grain crack strength.

A leather can be considered "pulpy" by these low limits and "weak" by a higher set of strength limits which was chosen in our previous study (4) of plump hides and whole sides of leather. In this study a side of leather was considered "weak" when a third of the test specimens tested below the following limits: 2000 lbs./sq. in. in tensile strength, 400 lbs./in. in slit tear and 300 lbs. in Mullen grain crack strength. These limits were used to judge whole sides of leather and thus they are higher values than those that would apply to the kidney area only. We used the higher limits to define weakness in the kidney area and selected the lower limits to define pulpiness.

Using the defined limits and considering that a leather sample was failing when two or three of the strength measurements fell below the limits, incidence

†Many slides that were prepared for the histological studies were photographed at the Eastern Regional Research Laboratory. Selected ones are presented and discussed in this issue of the *Journal* in a paper by Everett, Willard and Windus.

figures were calculated as shown in Table I. The six experiments are reported separately to show seasonal trends. Average values for weakness and pulpiness for Hereford hides compared with Angus and Holstein hides are given to show breed differences. The October and December data are both divided into two parts. Only 20 Hereford hides were available in October, thus the 130 Angus and Holstein hides that were selected are reported separately as "A" and "B" in the table. In December Hereford hides only were selected. They were taken from packs from two sources, thus they are reported separately as "I" and "II."

TABLE I

INCIDENCE OF WEAKNESS AND PULPINESS IN SIDE UPPER LEATHER

	Hereford Hides			Angus and Holstein Hides		
Sampling Time	Sides Tested	Weak Leathers Including Pulpy* %	Pulpy* %	Sides Tested	Weak Leathers* %	Pulpy* %
February	146	22	9	109	4	0
April	157	17	3	135	1	0
June	158	15	4	135	2	0
August	128	25	10	168	1	0
October† A	20	—	—	143	0	0
B	—	—	—	126	2	0
December‡ I	143	24	7	—	—	—
II	145	9	2	—	—	—
Average	—	18	6	—	2	0

*Results represent the percentage of leather sides tested that were poor in strength.
†Hereford hides were unavailable in October. "A" = Angus hides. "B" = Holstein hides.
‡Hereford hides only were selected. They are represented by two lots, "I" and "II," each from a different source.

The results in Table I show that there were no definite seasonal trends in the selection of hides tested. There was more difference between lots of hides than between seasons. Hides of February, August and December I produced more weak and pulpy leather than hides of April, June and December II. A great difference that can be seen in the results is the variation in breeds; most of the weak leathers and all of the pulpy leathers originated from Hereford hides. Eighteen percent of the Hereford hides produced weak leather; six percent were extremely weak and were rated pulpy. Only two percent of the Angus and Holstein hides produced weak leather; none of these was pulpy.

Histological Studies

A. Cure Evaluations

The 360 samples selected for histological studies were examined for degree of preservation. The results are given in Table II. Good, fair or poor ratings were used; the low, medium and high strength hides were considered separately. The cure evaluations indicated that the February and April hides, which represented winter take-off, were rated in good condition whereas the June, August, October and December hides, which represented spring, summer and fall take-off, were rated in a fair to poor condition.

TABLE II

DEGREE OF PRESERVATION OF THE HIDES STUDIED HISTOLOGICALLY

	Low Strength Sides*			Medium Strength Sides			High Strength Sides		
Sampling Time	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
February	14**	6	0	13	7	0	13	7	0
April	13	7	0	15	5	0	17	3	0
June	1	13	6	0	17	3	0	20	0
August	2	14	4	1	17	2	0	17	3
October†	0	16	4	3	17	0	0	18	0
December‡	1	15	2	0	10	6	3	17	0

*Strength was based on the tensile strength of the hide.

**Figures represent the number of sides rated that were in a "good," "fair," or "poor" state of preservation out of 20 checked.

†Two specimens were lost.

‡Six specimens were lost.

Studies were made to see whether or not the values for the hides ranging from high to low in tensile strength and the ratings for degree of preservation ranging from good to poor were correlated. There was a slight indication from the June and August lots that some deterioration of the hides could be correlated with poor strength but from the other four lots there was no correlation. The overall indication from the studies was that factors other than the state of preservation have an influence on the physical strength of the hide and its resultant leather.

B. Fat Evaluations

The above 360 samples were graded histologically in respect to the amount of natural fat that was present in the corium of the hide. The results are given in Table III. A five point system with 5 representing very high fat content in the corium, 4—high amount, 3—moderate amount, 2—low amount, 1—no fat, was used; the average values for each set of 20 samples, which represented hides that were low, medium, and high in tensile strength, are given for each of the six lots of hides.

The results show that there was a slight seasonal trend. The data were averaged in respect to time of selection. The average figures represent 60 hide samples and indicate that the April, June and August hides contained the most

TABLE III

AMOUNT OF FAT PRESENT IN THE CORIUM OF THE HIDE STUDIED HISTOLOGICALLY

Sampling Time	Low Strength Sides*	Medium Strength Sides	High Strength Sides	Average
February	3.0**	2.1	1.9	2.3
April	4.2	3.0	2.1	3.1
June	3.3	2.1	2.3	2.6
August	3.2	3.0	2.4	2.9
October	3.0	1.9	1.3	2.1
December	3.4	1.6	1.3	2.1
Average	3.4	2.3	1.9	—

*Strength was based on the tensile strength of the hide.
**Each figure represents the average of the ratings for 20 sides checked.
Code used for grading individual cross sections:

Very high fat content	5
High amount	4
Moderate amount	3
Low amount	2
No fat	1

fat while the October, December and February hides contained the least fat. These results indicate that the late winter, spring and summer hides contained slightly more fat than the fall and early winter hides. A more important difference is seen when the strength of the hide is considered. The results were averaged in respect to the strength of the hide with each average figure representing 120 hide samples. These results, which are based on a fairly large population of hides, indicate that there is a trend that the hides low in strength in the kidney area contain a greater amount of fat in the corium than the hides medium and high in strength in the kidney area.

C. *Angle of Weave Evaluations*

Many cross sections of the cured hide samples were examined in respect to the architectural weave of the collagen fiber bundles. The vertical and horizontal sections definitely indicated that the hides that produced the pulpy leather showed many fiber bundles woven in a direction vertical to the grain surface and a few woven in a direction horizontal to the grain surface. The accompanying paper by Everett et al., shows a number of photomicrographs illustrating this defective fiber structure, as well as the corium fat evaluated above.

The paraffin sections of the finished leathers were equally demonstrative of the structural influence on the physical strength. In Figure 1 the angle of weave of fiber bundles was plotted against the Mullen grain crack strength of representative samples from the six lots of leather. The angle of weave represents the

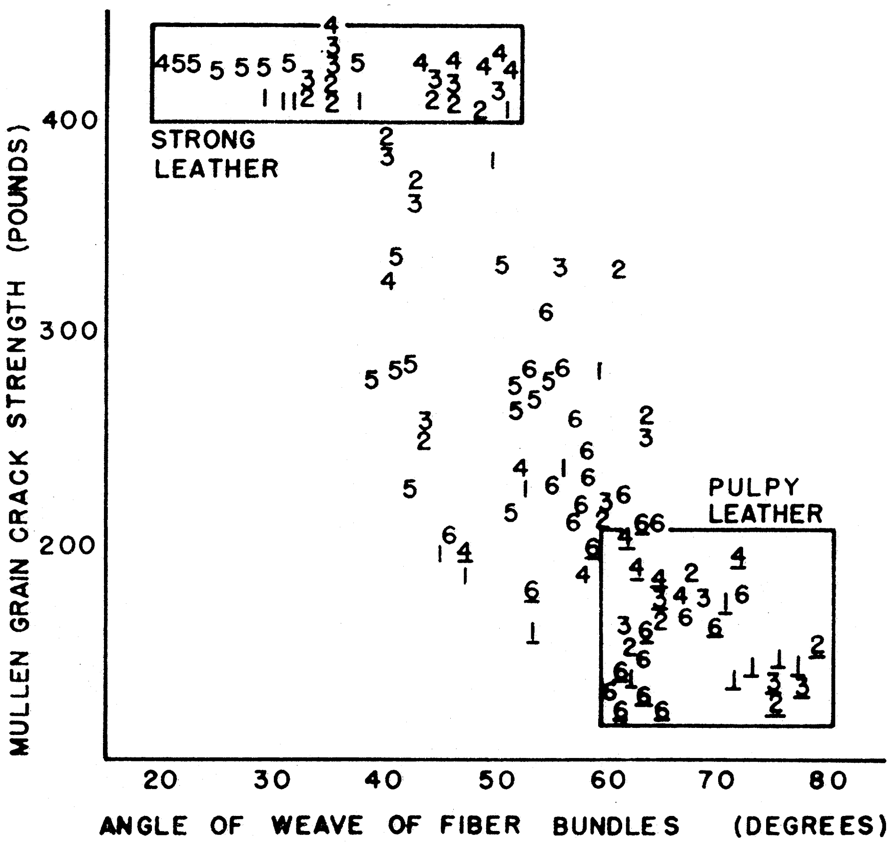

FIGURE 1.—Graph showing the relationship between the angles of weave of the corium fiber bundles and the Mullen grain crack strength for 4 oz. side upper leather.

average value for 16 measurements, while the Mullen grain crack strength represents the average value for two readings. The numbers 1 to 6 correspond to the six lots of leather studied and were used repeatedly to identify a sample taken from a side belonging to the corresponding lot. An underscore was used to designate that the sample was from a side which was characterized as pulpy leather. The graph shows the following:

1. When Mullen grain crack resistance was poor, less than 210 lbs., the angles of weave of the corium fiber bundles were between 60° and 80°. Most of the pulpy leather fell in this group. Note the block of data in the lower right hand corner of Figure 1.

2. When Mullen grain crack resistance was good, over 400 lbs., the angles of weave were between 20° and 52°. The strong leathers fell in this group. Note the block of data in the upper left hand corner of Figure 1.

3. The weak leathers had angles of weave between 40° and 65°.

Influence of Plumpness on Leather Strength

As mentioned previously, weights and areas were recorded for each hide so that pulpiness in leather could be compared to the plumpness of the hide. For each lot of hides, two area-weight graphs were plotted, one for Hereford hides and the other for Angus and Holstein hides.

The graphs in Figure 2‡ show the Hereford hide data for the months of February, April, June, August and December. Since Hereford hides only were selected in December, the data were divided into two graphs marked December I and December II. The weight of the cured hide as it was recorded in the hide cellar is given by the ordinate axis; the area of the hide, as it was measured "in the blue" in Allis Chalmers units, is given by the abscissa axis. A line which represents 1.36 pounds per square foot of plumpness (1.43 pounds per Allis Chalmers units) is drawn in each graph. All hides to the left of this arbitrarily chosen line are plump; all hides to the right are spready. The graphs in Figure 2 show that the plump Hereford hides rather than the spready Hereford hides produced the weak leather. There were 51 pulpy sides of leather found in these experiments. The graphs show that the plump Hereford hides rather than the spready Hereford hides produced the pulpy leather; 47 out of the 51 pulpy leathers originated from plump hides.

The graphs in Figure 3 show the Angus and Holstein hide data for the months of February, April, June, August and October. Most of the data represent Angus hides in the first four selections. The data represented both breeds in the October selection; the Angus hide data are plotted on the "A" graph; the Holstein hide data on the "B" graph. The graphs have been marked in the same manner as the graphs in Figure 2 to show the 1.36 lbs./sq. ft. plumpness line and leathers testing weak in physical strength. The graphs show that almost all of the Angus and Holstein hides produced strong leather. In these experiments, the Angus and Holstein hides in a weight range of 43 to 53 lbs. did not produce pulpy leather.

Bilateral Symmetry

As can be seen from the graphs there were many hides which showed bilateral symmetry, that is, the left and right sides of the backbone were similar. Bilateral symmetry definitely existed for pulpiness. There were 51 sides of pulpy leather in the six experiments. Thirty-eight of these represented left and right sides of nineteen hides. Out of the 13 samples remaining five pulpy sides had mates which were lost in the tannery and five pulpy sides had mates that were weak but were not quite weak enough to be pulpy. Only three had mates that were strong by the limits selected.

‡On the graphs a dash represents one hide. A small circle by a dash means a side was lost in the tannery and the leather was not available for testing. The light parentheses to the right or left of a dash indicate that the leather made from the hide was weak on the left or right side of the backbone in two or three of the physical tests which were: tensile strength, slit tear and Mullen grain crack strength. A heavy parenthesis indicates that a side was pulpy. This code also applies to Figures 3, 4, and 5.

Predicting Leather Strength

Three physical tests were run on the hide samples to see whether or not they correlated with the strength of the leather. Slit tear resistance showed poor re-

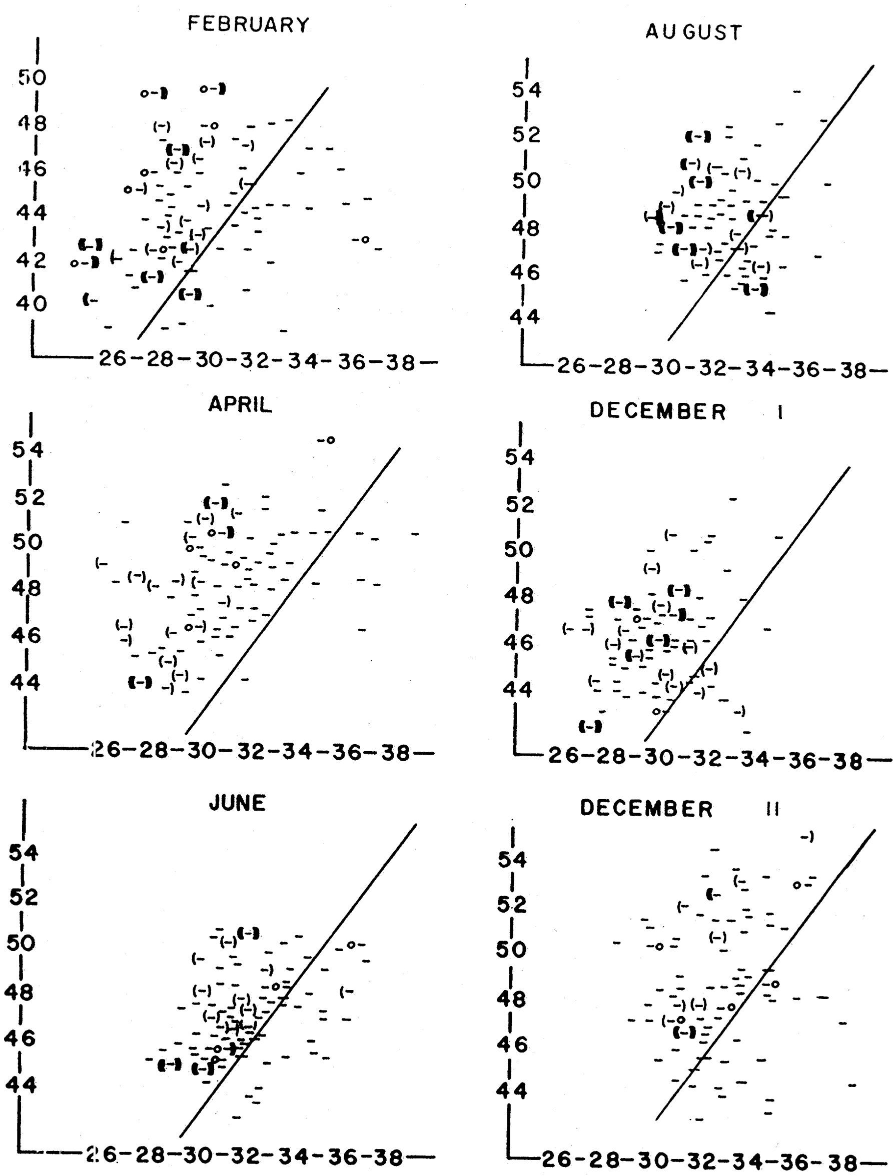

FIGURE 2.—Graphs for Hereford hide data which show the influence of the plumpness of the hide on the strength of the leather. The weight of the cured hide in pounds is given by the ordinate axis; the area of the leather in Allis Chalmers units measured "in the blue" is shown by the abscissa axis.

sults; puncture resistance showed fair results. The best results from a single physical strength test were given by tensile strength data. When these data were plotted against the tensile strength data of the finished leather, graphs were ob-

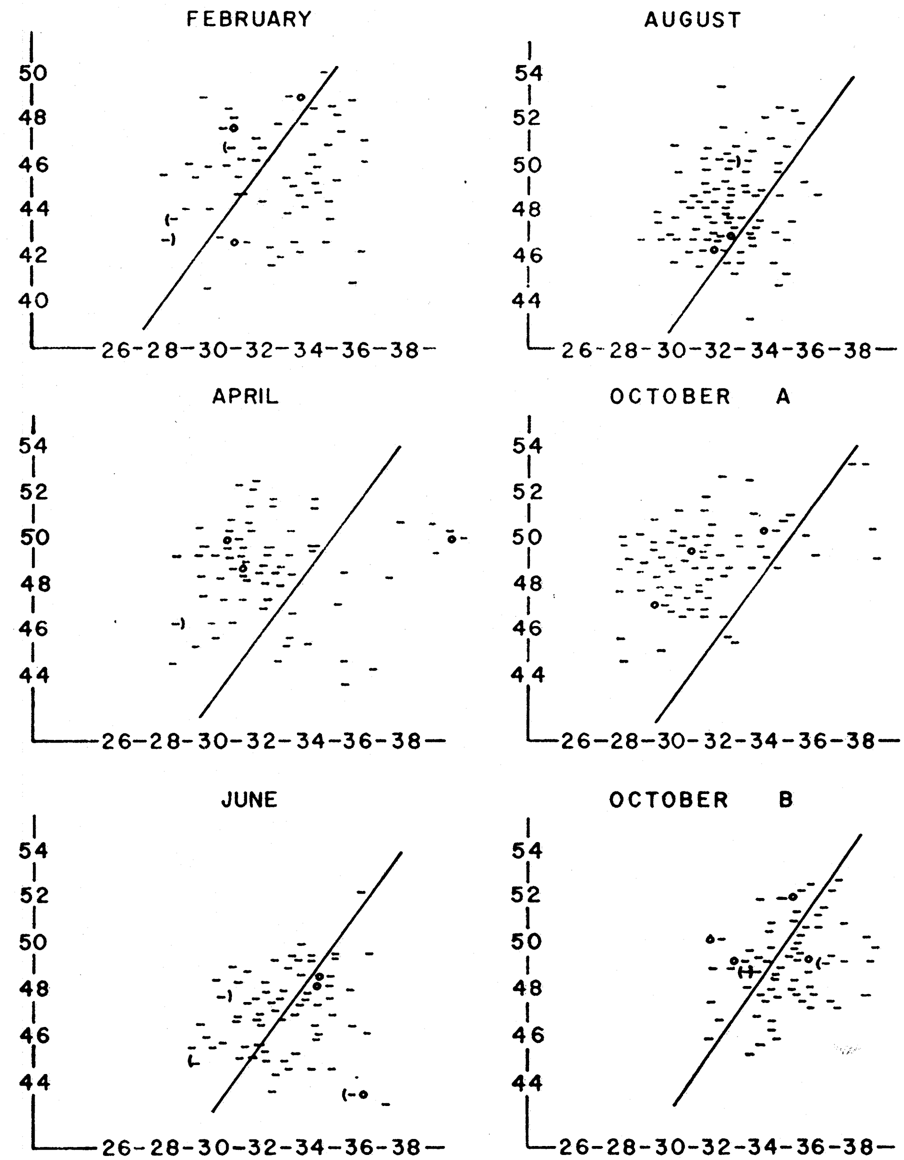

FIGURE 3.—Graphs for Angus and Holstein hide data which show the influence of the plumpness of the hide on the strength of the leather. The weight of the cured hide in pounds is given by the ordinate axis; the area of the leather in Allis Chalmers units measured "in the blue" is shown by the abscissa axis.

tained that were useful for showing trends. The graphs, which are given in Figure 4, show the results for the Hereford hides; the Angus and Holstein hides made strong leather and thus the data were not plotted. The tensile strengths for the hides are given by the abscissa axis; the tensile strengths for their leathers are given by the ordinate axis. All figures represent the average values of four specimens tested and are expressed in a simplified form by dividing the lbs./sq. in. by 100.

The leathers testing weak and pulpy are indicated. The points do not always fall below the limits assigned for weak and pulpy because they represent an average value for the left and right sides. The graphs show that there is a relationship between the leather strength and the hide strength. The Hereford hides testing less than 2800 lbs./sq. in. in tensile strength, in general, produced most of the weak and most of the pulpy leathers.

The information obtained from Figures 2, 3 and 4 indicated that another type of graph which was called the "Quadrant Graph," could be plotted for Hereford hide data. The graphs are given in Figure 5 and show the interaction that exists between the plumpness information of Figure 2 and the tensile strength information of Figure 4. The plumpness values in Allis Chalmers units are given by the abscissa axis. The tensile strength values, which are the averages of the data for the left and right sides, are given by the ordinate axis. Quadrants are obtained by placing one dividing line at the position which represents 1.43 lbs./Allis Chalmers unit. This is the same as 1.36 lbs./sq. ft. The other dividing line is placed at the 2800 lbs./sq. in. tensile strength position.

The graphs indicate that the strength of the leathers made from Hereford hides can be predicted fairly well on a basis of plumpness and tensile strength of the hides. The weak plump hides of Quadrant IV produced most of the weak and pulpy leathers. Most of the strong plump hides in Quadrant I produced strong leathers. The strong spready hides in Quadrant II produced strong leathers. There were only a few weak spready hides in Quadrant III.

Separation of Hides Producing Weak Leather

A flowsheet, which is shown in Figure 6, was designed to sort selectively for hides that produce weak leather. The 1718 sides tested were from an assortment of Angus, Holstein and Hereford hides. These sides produced 169 weak sides of leather of which 51 were physically and visually pulpy. The first separation removes the Angus and Holstein hides which takes out 828 sides. In removing these, 11 (6 percent) of the weak sides but none of the pulpy sides are removed. The remaining 890 sides were of Hereford type and produced 158 (94 percent) of the weak sides and 51 (100 percent) of the pulpy sides of leather.

The second separation consists of removing the spready Hereford hides — those having plumpness values less than 1.36 lbs./sq. ft. This step removes 222 sides, which accounts for only 13 (eight percent) of the weak sides and four

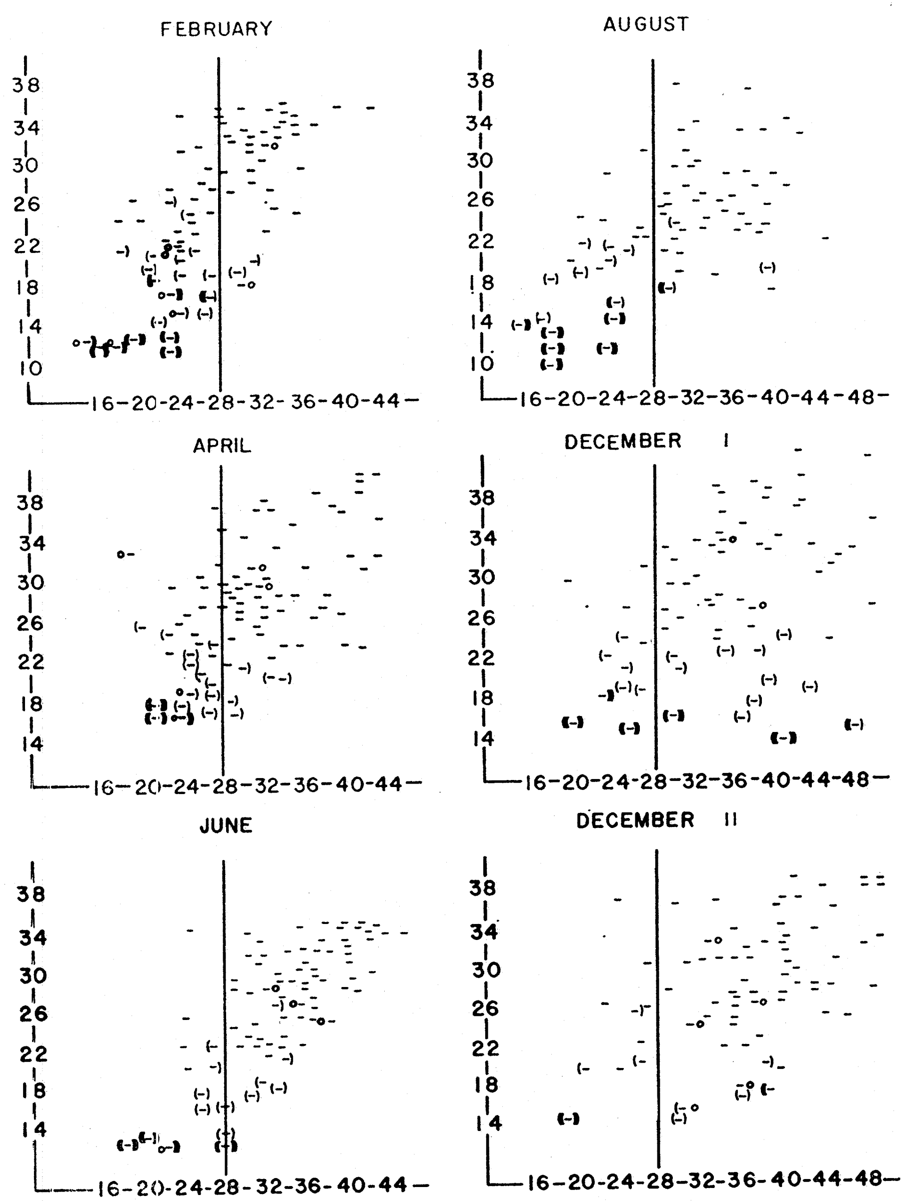

FIGURE 4.—Graphs for Hereford hide data which show the relationship between the tensile strength of the cured hide and the tensile strength of the finished 4 oz. side upper leather. The average of four tensile strength values for the cured hide in lbs./sq. in. (divided by 100 for simplification) is given by the abscissa axis. The average of four tensile strength values for the finished leather in lbs./sq. in. (divided by 100 for simplification) is given by the ordinate axis.

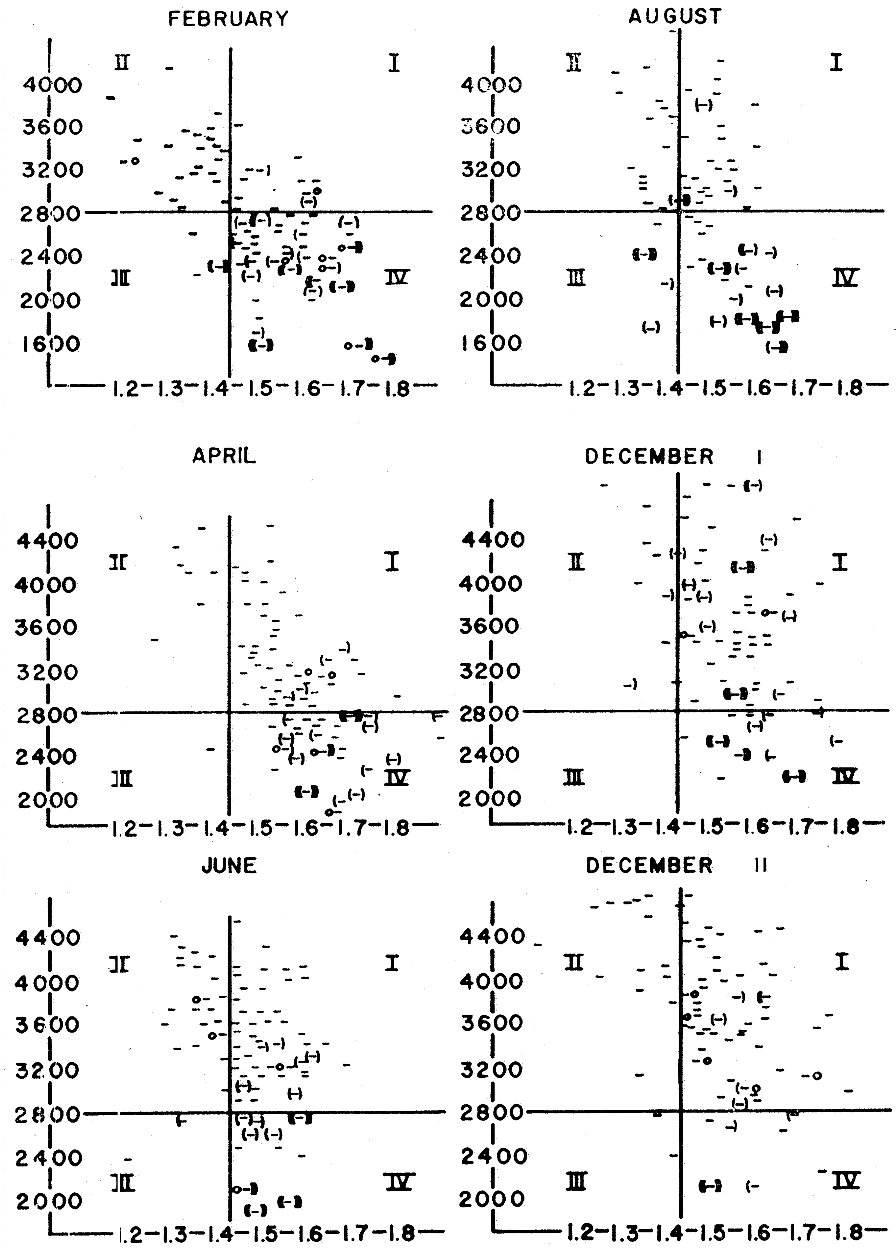

FIGURE 5.—"Quadrant Graphs" for Hereford hide data showing the interaction that exists between the plumpness of the hide and the tensile strength of the hide. The plumpness in Allis Chalmers units is given by the abscissa axis. The average of four tensile strength values in pounds per sq. in. is given by the ordinate axis.

TEST RESULTS FOR MORE THAN 800 HIDES

1718 sides from ANGUS,
HEREFORD and HOLSTEIN hides
produced 169 weak sides of
leather of which 51 were pulpy

828 sides from ANGUS and
HOLSTEINS produced:

11 (6%) of the weak sides
0 (0%) of the pulpy sides

890 sides from HEREFORDS
produced:

158 (94%) of the weak sides
51 (100%) of the pulpy sides

222 sides from SPREADY
HEREFORDS (< 1.36 lbs./sq. ft.)

13 (8%) of the weak sides
4 (8%) of the pulpy sides

668 sides from PLUMP
HEREFORDS (> 1.36 lbs./sq. ft.)

145 (86%) of the weak sides
47 (92%) of the pulpy sides

457 sides from STRONG PLUMP
HEREFORDS (> 2800 lbs./sq. in.
tensile strength) produced:

47 (28%) of the weak sides
7 (14%) of the pulpy sides

211 sides from WEAK PLUMP
HEREFORDS (< 2800 lbs./sq. in.
tensile strength) produced:

98 (58%) of the weak sides
40 (78%) of the pulpy sides

FIGURE 6.—Flowsheet showing the results of testing more than 800 cured hides, 43 to 53 pounds cured weight, and a scheme for concentrating the weak leather producing hides.

(eight percent) of the pulpy sides. The 668 plump sides remaining produced 145 (86 percent) of the weak leathers and 47 (92 percent) of the pulpy leathers.

The last separation is based on tensile strength in the kidney area and divides the plump Herefords into sides testing greater than 2800 lbs./sq. in. and sides testing lower than 2800 lbs./sq. in. This separation is not quite as definitive as the other two separations but it does separate most of the hides producing weak leather into a group of 211 sides which is 12 percent of the total number used for the experiment. The 211 weak plump Hereford sides produced 98 (58 percent) of the weak and 40 (78 percent) of the pulpy sides of leather.

Statistical Analyses

Using an IBM 1620 computer and developing a card format which accommodated the data, statistical analyses were run to determine the best single hide characteristic for predicting a combined leather strength. "Combined" means that three tests — tensile strength, slit tear and Mullen grain crack strength — were used to determine the strength of the leather. The best leather combination was obtained from a simple addition of the three tests; tensile strength in lbs. + slit tear in lbs. + Mullen grain crack strength in pounds. The correlation coefficients indicated that the single hide characteristics that predicted the combined leather strength the best were tensile strengh of the hide in lbs./sq. in., plumpness of the hide in lbs./sq. ft. and puncture resistance of the hide in lbs./in., in order of decreasing merit. Other single hide charateristics checked were tensile strength in pounds, puncture in pounds and toughness of the hide (10). These characteristics were not as good as the first three mentioned for predicting the combined leather strength. Although slit tear strengths were run on all hide specimens they were not checked statistically because there was poor agreement between the hide slit tear data and the leather strength.

Multiple correlation studies were also made to check the possibility that several hide variables multiplied together may improve predictability. There was slight improvement over one variable when two variables were multiplied together and slightly more improvement over two variables when more than two variables were multiplied together. However, the improvement did not warrant the use of a multiple value.

The statistical analyses confirmed the interpretations made from the graphs shown in Figures 2 through 4. Besides the influence of breed, the plumpness of the hide in lbs./sq. ft. and the tensile strength of the hide in lbs./sq. in. were the most important factors concerned with predicting leather strength.

SUMMARY

A selection of more than 800 salt cured hides in a range of 43 to 53 pounds cured weight has enabled us to study the incidence and predictability of pulpiness in side upper leather. Most of the hides involved with pulpiness and weakness were plump Hereford hides and a three step scheme for separating hides likely

to produce pulpy leather was evolved. The scheme is not perfect, because predicting the strength of a 4 oz. shoe upper type leather from full thickness hide characteristics is difficult. Also, a number of strong hides which produce satisfactory leather remain in the weak, plump Hereford group. A suitable use must be found for the hides that are segregated; a leather not requiring high tensile strength, such as sole leather, may be a legitimate outlet, in which case the sorting or evaluation must be done before chrome tanning. Although these drawbacks exist, the method does have merit. It can remove many hides that produce weak leather and thus eliminate a sizeable portion of the economic loss involved with the pulpy condition. By taking out these hides, the tanner can produce leather of more uniform qualities and assure a better product to the consumer.

CONCLUSIONS

1. It has been established that the Hereford hides produced most of the leathers weak in strength characteristics and all the leathers that were pulpy. Eighteen percent of the Hereford hides produced weak leather and six percent produced pulpy leather. Only two percent of the Angus and Holstein hides produced weak leather, none of which was pulpy.

2. Vertical and horizontal sections of the hide samples and vertical sections of the leather samples showed that the physical strength characteristics of the hide and the leather were influenced by the orientation of the corium fiber bundles.

3. The Hereford hides that were plump produced almost all of the leathers poor in strength characteristics.

4. Hereford hides testing lower than 2800 lbs./sq. in. in tensile strength in the kidney area were more likely to produce pulpy and weak leather than those testing higher than 2800 lbs./sq. in. in tensile strength.

5. Many of the hides that produce weak leather can be eliminated from packs of hides by sorting out Angus, Holsteins, spready Herefords and making tensile strength measurements on plump Herefords. However, none of the physical tests used in this investigation provided a simple and infallible method for predicting weakness and pulpiness occurring in side upper leather.

ACKNOWLEDGMENT

The cooperation of the Rueping Leather Company in permitting R. Schmitt to select hides at their plant, in recording the areas of the leathers in the blue and in sampling the finished leathers made from the hides is gratefully acknowledged. The technical assistance of J. Eken, J. Day, J. Holder, G. Conley, J. deGroot, J. Klosterman, S. Marcus, J. Diedrich, T. Fudge, J. Schulze, S. Baron and M. Topel has been important in completing the work and is sincerely appreciated. In obtaining the statistical evaluations, the help of Professor R. Fopma has been valuable. The authors express thanks to Professor W. T. Roddy and

Dr. F. O'Flaherty of the Tanners' Council Laboratory and to Dr. J. Naghski and the late Mr. J. Boyd of the Eastern Regional Research Laboratory for their guidance and criticism through the research program.

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DISCUSSION

PRESIDENT MEO: The discussion on this paper will be led by Mr. Joe Bassett.

MR. JOSEPH A. BASSETT (A. C. Lawrence Leather Co.): Mrs. Tancous has presented a paper this morning which, I am sure, all of you will agree will have far-reaching implications for side-leather tanners, both those in the United States and those abroad who may be interested in our hides. I think every side-leather tanner here should study this paper very carefully.

We don't have time enough this morning to go into an elaborate discussion of the paper. I should like now, though, to ask a question of Mrs. Tancous, which pertains to the last slide which she showed. I wonder if we could have the slide on the screen again, please? If you will recall, she made a separation of hides and ended up with a group of 211 which contained the weak hides in this trial. The question that I have for her pertains to the strong sides which may have appeared in this group. I should like to ask Mrs. Tancous, how many strong hides were thrown out in this selection and I should like her to elaborate on this just a little bit, please?

MRS. TANCOUS: The first separation took out the Angus and the Holstein sides, and removed very few weak and pulpy sides. The second separation took out the spready hides and was a fairly good separation. The third one was not as definitive as the other two, but it can be used. Unfortunately, some of our good leather-producing hides did fall into this group. I would estimate that at least 100 out of the 211 in this group made strong leather.

We have studied the structure of the hides all the way through this experiment. One of the reasons why the third separation is not better is that we are testing a full thickness hide. The corium of many of the weak hides contains much fat. Naturally, the fat will not contribute to the strength of the hide. When a hide has fat incorporated inside the corium, and has vertical fibers above the fat, then we have a pulpy hide. But if we have an orientation of fiber bundles with a low angle of weave in the upper corium, then, even though the hide has much fat and is weak as a hide, it will make a strong piece of leather. For this reason the 211 hides in this group did contain some hides producing strong leather. So, a tanner has to realize that if he uses this separation, it is not completely definitive in the last group. Really, we need another test that will be better than tensile strength. However, it is the best test that we have so far.

As I say, it is because we are testing a full-thickness hide and because we are getting the lower part of the corium involved that we are having trouble. If we had a test where we split off the corium before we ran a physical strength test, we would have much better predictability.

Mr. Bassett: Are there questions from the floor?

Mr. Raymond A. Hauck (S. B. Foot Tanning Co.): Jean, referring to your correlation of histological studies and physical strength and going back to the previous paper, to staining techniques that Mr. Everett used, would it be possible to use a staining technique on these fresh hides or on the cured hides, that would show a depth of dye penetration? Could you see whether or not you had a more vertical fiber structure and pick out the hides that were weak from the ones that were strong? Would this be another tool in preference to the use of tensile testing?

Mrs. Tancous: The study of the orientation of fiber bundles involves using a microscope. I don't believe we can just cut open a hide and say that it is going to be a pulpy butt or a good, strong hide.

Mr. Hauck: May I continue there? I was thinking of the total depth of penetration. I noticed in the previous work that Mr. Everett practically had complete dye penetration into vertical bundles; whereas he had very little dye penetration into horizontal bundles.

Mrs. Tancous: You saw the dye penetration in the finished leather. We are trying to predict from hides. If we can differentiate hides and put them into the proper type production, we are saving the industry money.

MR. HAUCK: Right. I was wondering if you could dye the hide this way.

MRS. TANCOUS: In the leather you have something split. As worked in the tannery, the more agitation a pulpy leather receives, the more it opens up, and thus more fat liquor and dye will penetrate into the area.

In the hide we have a tight structure, and I don't believe this would work. The hide is unopened and compact with moisture, fat and hide substance. For a dye to penetrate, the hide should be split and then given some type of mechanical agitation.

We did try specific gravity to pick out the hides that contained fat. It does have possibilities, but the hide has to contain a tremendous amount of fat before it will float to the top of a brine solution.

MR. R. I. MILLER (Armour and Company): Did you make any attempt to differentiate between cow and steer hides, particularly in the case of the Herefords?

MRS. TANCOUS: No, we didn't. We had pretty much to look for as it was. We didn't make any sex differentiation.

MR. R. I. MILLER: Do you think that would be important?

MRS. TANCOUS: Yes. There are many aspects to this problem that could be studied. We are just getting started. I think you can see that.

MR. I. LEO RIESE (Allied Kid Company): What factor caused you to use 1.36 pounds per square foot as a criterion for the separation between spready and plump hides?

MRS. TANCOUS: After we had data for two or three lots, we arbitrarily chose this line, because those hides that were giving weak leather were to the left of the line and those that were producing strong leather were to the right. This is an arbitrarily chosen line.

MR. HOPKINS (Eastern Regional Research Laboratory): I was just wondering if you would care to comment, Mrs. Tancous, on the contribution that pulpiness might have to a vascular condition called veininess. Are they related?

MRS. TANCOUS: You can have veininess which shows up in a pulpy leather, particularly on the flesh side. It may or may not show on the grain side. Many dairy cattle hides will have veininess and will not have pulpiness at all. There is some relationship, but it is not directly related.

MR. BASSETT: Are there any further questions?

MR. E. F. HARDS (A. C. Lawrence Leather Co.): Did you make splits from hese hides eventually?

MRS. TANCOUS: They were split and made into side upper leather.

MR. HARDS: Did you keep the splits and check those?

MRS. TANCOUS: We had cross-sections of the original hides in many instances, so that we could refer back to these and see what structural differences were involved with the problem. We did not measure physical strength or make leather out of the splits, if that is what you had in mind.

MR. HARDS: I see.

MRS. TANCOUS: The splits were taken off in the tannery. I don't know what they did with them.

MR. HARDS: Horsehide has a vertical structure in the bend area as opposed to a horizontal architecture in the rest of the hide. Does this relate in any way with the vertical structure of a steer hide?

MRS. TANCOUS: Because of this difference, the bend area is cut from the horsehide and processed separately from the rest. We do not advocate cutting the steerhide but would like the plump, weak Hereford hides processed into sole leather where the higher the angle, the better the wear, because you're cutting off the bottom of the fiber and not taking off whole horizontal fibers. Even though we are getting a proportion of strong, leather-producing hides in the weak, plump Hereford group, they would not be wasted at a sole leather plant. At the same time the weak leather producing hides would not cause a problem. It's just when they are split open and made into side upper leather that the pulpy leather is produced.

MR. HARDS: Thank you.

MR. BASSETT: Are there any other questions at this time?

I should like to thank Jean Tancous for presenting this most interesting paper, which I'm sure is going to receive a lot of discussion in the days to come.